MOSQUITO CONNECTION

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West Nile's Widening Toll Impact on North American Wildlife Far Worse Than on Humans

(*Wing Beats*, Winter 2002)

First there was the silence of the crows. Then the horses fell ill--more than 14,000 last summer alone--along with squirrels, chipmunks, and mountain goats. Even mighty raptors--eagles, hawks and the great horned owls--dropped from the sky.

Now scientists are beginning to take stock of West Nile virus's North American invasion, and they are taken aback by the scale and sweep of its ecological impact. While the human toll dominated the nation's attention this year--the virus killed at least 241 people and infected many thousands more--the effects on wildlife were far worse.

The virus swept westward with alarming rapidity this year, appearing in almost every state in the nation--an astonishing expansion for a bug that had never been seen in the Western Hemisphere until three years ago. Equally unexpected, nearly 200 species of birds, reptiles, and mammals fell ill from West Nile this year, including rabbits and reindeer, pelicans and bats, even a few dogs and cats. The virus also slammed dozens of exotic species in about 100 U.S. zoos, killing cockatiels, emus, seals, flamingos, and penguins. Florida alligator farms lost more than 200 of the reptiles.

"In my years of working, I've never seen a mosquito-borne virus spread so quickly," said Robert G. McLean with the Agriculture Department's National Wildlife Research Center in Fort Collins, Colorado.

West Nile is not fatal in all animals, and over time some species are expected to adapt. But even partial drop-offs in key populations could have serious consequences. Rodent populations could blossom in areas where raptors are dying, and pest birds such as house sparrows may be increasing where crows are absent.

The worst is still ahead, scientists say. Come spring, West Nile is expected to complete its push to the West Coast, home to endangered whooping cranes and economically important flocks of domestic geese. The virus is also poised to leap to the subtropics, where rare birds and other vulnerable creatures already face formidable threats to their survival.

North American Debut

West Nile made its North American debut in the fall of 1999, discovered in a dead New York crow. Scientists don't know how the virus reached U. S. shores--perhaps it hid inside a single infected bird imported from the Middle East. But one thing is certain, said Stephen Ostroff of the Center for Disease Control and Prevention (CDC) in Atlanta: "There's no way that West Nile is going to go away."

The virus appears no more virulent in Americans than in other people around the world and scientists suspect that the population will gradually gain immunity through low-level exposures. That is the situation today in countries where the virus has been active for many years. Most people in those countries have antibodies to the virus from early childhood, and serious complications or death from West Nile are rare.

But in North American wildlife, the virus has proven to be unusually aggressive and capable of infecting a surprisingly diverse array of animals.

"Most viruses tend to be rather host-specific, but that's not the case with what we were seeing," said Tracey McNarmara, Chief of Pathology for the Wildlife Conservation Society, which had its headquarters at the Bronx Zoo, where the first infected crow was found.

It is still unclear how many of the 200 or so species struck by West Nile infection has suffered significant population declines. But a consensus is emerging among birds, in particular, far more species are being hurt than scientists had predicted--not just the crows, ravens, and jays that were know to be especially vulnerable.

"There's been a huge die-off of raptors," said McLean of the agriculture department's Fort Collins lab.

The experience of the University of Minnesota's Raptor Center, which rehabilitates sick and injured raptors, was typical. "In mid-August, we had our first case: a great horned owl," said spokeswoman Sue Kirchoff. "In September and October we, were just inundated."

The center took in 70 ailing birds of prey, including great horned owls, eagles, and red tailed hawks. Officials there presume that if that many were found and brought to the center, countless others died in the wild with potentially far-ranging repercussions.

"From a biological standpoint, raptors take longer to mature and have fewer offspring" than smaller birds, said Patti Bright for the American Bird Conservancy. "Whether they'll be able to rebound, well we just don't know." It will take a while longer, Bright and others said, before it is known whether rodent populations are taking advantage of West Nile's impact on birds of prey.

The evidence for declines in songbirds and other small avian species is less direct, in part because they are so much less visible. "We're simply not going to know for awhile with the smaller birds, because we're not going to find the bodies," David S. Wilcove, a professor of ecology at Princeton University who had been studying West Nile.

Researchers this year found more than 140 birds species sickened or dead with West Nile, including chickadees, doves, grackles, gulls, herons, kingfishers, pelicans, sparrows, swans, turkeys, warblers, woodpeckers, and wrens. And while most of those species will probably pull through as resistant individuals, mate, and pass their antiviral vigor to their offspring, ornithologists expect that others will not be so lucky.

Bird-to-Bird Infection

One surprise is that the virus can be transmitted directly from bird to bird, not only via mosquitoes. Raptors can acquire the virus by eating infected prey, and some birds can apparently spread the virus by eating infected prey, and some birds can apparently spread the virus in their droppings. There's also evidence that some birds can pass the virus directly to their chicks while they're still inside the egg.

Another surprise is that West Nile virus can be transmitted directly from adult mosquitoes to their eggs, so that newly hatched aquatic larvae are born infected. That could make insecticides, which typically kill only adults, less effective.

Scientists have also been surprised to learn that the virus can persevere through the winter, even in many Northern states. Researchers are not sure which animals are serving as the virus's winter host, but the phenomenon is allowing the disease to spread year round and is giving the summer viral eruption an earlier start each year.

Yet another surprise is the number of mosquito species---36 at last count---that carry the virus. "This is a virus that's never seen a mosquito it doesn't like," said Ostroff of the CDC. "That's not typical for most pathogenic viruses."

If that weren't enough, some researchers suspect that West Nile might be capable of mixing its genetic material with that of a closely related virus such as the one that causes St. Louis encephalitis, if both viruses were to infect a single animal. Other viruses have periodically produced an entirely new and dangerous bug.

"This virus is amazing," said CDC virologist Robert S. Lanciotti. "I've been in this field almost 20 years, and I've never seen anything like it."

Neither has the state of California, but it is about to, experts say.

"It's going to spread to the West Coast big time next year 2003, no question,"USDA's McLean said. "Each habitat is different, but California seems to be an area that had all the factors you need for a major spread. I think they're going to be facing problems in humans, horses, birds and other animals. I just don't see any barriers."

Such predictions have a particularly ominous ring for researchers on the California Condor Recovery Team, who have been struggling to bring the ungainly bird back from the brink of extinction. They knew that this summer's experimental inoculations of zoo birds with the horse vaccine---the only West Nile vaccine approved for marketing in this country—had been disappointing, with many bird failing to develop protective antibodies. So in November, veterinarians at the Los Angeles and San Diego zoos injected into the thighs of their condors an experimental vaccine to try to confer immunity before the spring egg-laying season.

"We had absolutely zero negative effects," said Cynthia Stringfield, veterinarian of the Los Angeles Zoo, and preliminary blood test suggested that the birds had a fantastic immune response."

If further tests show that the vaccine works, the team will try to vaccinate all 128 captive California condors and the approximately 70 birds now living in the wild.

What Zoos Do

Zoos may take the lead in the fight against West Nile in more ways than that. More than 100 U. S. zoos and wildlife parks have joined a newly created information-sharing network, which had its headquarters at Chicago's Lincoln Park Zoo, to track West Nile and other emerging infections in exotic animals.

Some scientists suspect the network may even prove useful in the cause of homeland security, by providing a sensitive, nationwide "sentinel system" for detecting the first hints of a bioterrorism attack. After all, zoo officials noted, New York crows were dying in droves in the fall of 1999, but no one figured out that West Nile was the culprit--or that the deaths were related to a spate of unusual human illnesse--until a crow dies on the grounds of the Bronx Zoo.

Zoos, it turns out, take every death seriously--even those of non-zoo animals on zoo grounds--because any death can mark the start of a devastating epidemic. ""Every dead animal is picked up and immediately necropsied said McNamara, the Bronx Zoo pathologist. "That's not true in Central Park."

When the Bronx crow was found to be teeming with West Nile, it was the first evidence that the Old World virus had leaped the Atlantic---and the beginning of the recognition that an epidemic was already underway in humans. With a system in place, McNamara said, a zoo vet could be the first to know if terrorists have released a human or animal pathogen. The consortium is seeking federal funding.

Still, some scientists fear that the nation may soon become less able to prevent outbreaks such as that of West Nile—whether accidental or intentional. They said the U. S. system for screening incoming animal, plant and microbial life—a patchwork of more than 20 agencies—had long been under valued and underfunded. Now the largest component, the Agriculture Department's Animal and Plant Health Inspection Service, is to become part of the new Homeland Security Department. That's leading many ecologists to fear that it will narrow its focus to classical bioterrorism pathogens such as anthrax, leaving the nation more vulnerable to civilians bugs such as West Nile.

"I have a feeling that beetles in imported wood packaging are not going to be at the tip of the list," said Faith T. Campbell, director of the invasive species program at the American Lands Alliance in Washington. Yet the recent U. S. invasion by Asian longhorned beetles, which arrived in wood packaging from China, is expected to cost the nation as mush as $669 billion in insect-destroyed trees in urban areas alone in coming decades, Campbell said.

Whether West Nile ends up decimating many animal populations or settling in as a mere high-grade ecological disturbance, the epidemic should be a wake-up call to beef up the nation's surveillance and quarantine network said Princeton's Wilcove.

"We may be lucky this time and get by with minimal losses of human life and minimal losses of wildlife, but this is not going to be the last disease to get into this country," he said. "One of these days we're going to draw the short straw."

(*Editor's note: Wing Beats* is the official publication of the American Mosquito Control Association. This article originally appeared in the Dec. 28, 2002 issue of *The Washington Post*.)

Arizona Mosquito Arbovirus Update

Information Courtesy Arizona Department of Health Services.
Epidemiology and Disease Control, Vector-Borne and Zoonotic Disease Newsletter (Winter 2002)

Arizona is one of only four states among the 48 contiguous states that have not yet documented West Nile Virus (WNV) activity in state. The other WNV negative states include Nevada, Oregon and Utah. WNV was identified as the cause of meningitis in four Arizona residents with travel/exposure histories in other states: Indiana, Michigan, Illinois (or possibly Maryland) and Ohio. The four WNV meningitis cases resided in Maricopa (2) and Pima (2) counties.

WNV infection also was confirmed in three horses with neurologic disease reported in southern Arizona, including one each in Cochise, Maricopa, and Pima counties. All three horses had travel histories in other states prior to onset.

Mosquito Pools

For the last three years, state and county health officials in Arizona have been working hard to enhance surveillance efforts to detect WNV activity. With the help of many agencies and individuals throughout the state, health officials have been successful in establishing surveillance coverage in all fifteen counties. During the 2002 surveillance effort, Arizona State Health Laboratory (ASHL) personnel tested 753 pools, over 1,500 sentinel chicken blood samples, and over 100 human specimens (including blood serum). All were negative for WNV except for the human cases mentioned earlier. Additionally, staff at the University of Arizona—Veterinary Diagnostic Laboratory had tested over 200 dead birds. All were negative for WNV.

Other Arbovirus Surveillance

Surveillance efforts did detect other arboviruses, however. Twenty-eight mosquito pools tested positive, including 14 for St. Louis encephalitis (SLE) virus (Yuma County—9, Maricopa, 2, Pima—2, and Pina1, 1); and 14 for western equine encephalitis (WEE) virus (Yuma—10, Pinal—2, Maricopa—1, and Mohave, 1). Thirty-one sentinel chickens seroconverted (*def*.--to produce specific antibodies in response to the presence of an antigen such as a virus) to arboviruses, including 16 to SLE (Yuma—11, Maricopa—4, and Pima—1), and 15 to WEE (Yuma County—14 and Maricopa County—1). Finally, one horse with neurologic illness tested positive for WEE in Cochise County. County vector control personnel stepped up mosquito control efforts in the affected areas.

Two human cases of St. Louis encephalitis were reported in Maricopa County. One had onset of encephalitis symptoms in August and the other in October. Neither patient had traveled outside the county prior to onset.

Dengue

Two cases of dengue fever (one confirmed and one presumptive) were reported in 2002 in residents of Coconino County. Both patients had onset of symptoms (fever, headache, rash, joint and muscle pain) while vacationing in Thailand. Both patients reported getting mosquito bites on their feet while in Thailand.

Natives effective at mosquito control

Gila Topminnow vs. Western Mosquitofish: An Update

Dave Weedman, Fisheries Biologist
Native Fish Program
Arizona Game and Fish Department, Phoenix

The Gila topminnow (*Poeciliopsis occidentalis occidentalis*) in the early to mid 1900s, was considered the most common fish in Arizona. Today, it is near extinction.

The Gila topminnow is Arizona's only native live-bearing fish, historically found throughout the Gila River drainage of central and southern Arizona. The Gila topminnow's omnivorous feeding habits allow it to eat plant matter as well as insects, including mosquito larvae.

The western mosquitofish (*Gambusia affinis*) is also a small live-bearing fish in the same family as the Gila topminnow. The western mosquitofish found its way to Arizona and other parts of the arid Southwest around the 1920s. Settlers and government agencies transported mosquitofish to Arizona as a mechanism for controlling mosquito populations and related malaria outbreaks. It was also spread throughout Arizona as forage for other non-native fishes (bass, catfish, sunfishes, and crappie) that were being established for food and recreational fishing during this same period. Non-native fishes such as these have had a detrimental affect on Arizona's native fish species.

The Gila topminnow's battle for survival began during the early 1900s. Technological advances began pumping groundwater to the surface for agriculture, mining, and residential uses. Groundwater pumping resulted in lowered water tables, dry stream bottoms, and dry springs. Extensive overgrazing of the range resulted in increased erosion and arroyo cutting, causing additional decreases in water tables (Minckley and Deacon 1991). Mosquitofish became more abundant and widespread, resulting in serious impacts on topminnow populations through predation and competition. When these factors were combined, they caused the drastic decline in distribution and abundance of Gila topminnow. The decline of the topminnow resulted in its listing under the Endangered Species Protection Act of 1966 and later under the Endangered Species Act of 1973. By the early 1980s,

the Gila topminnow was reduced to approximately 10 geographically isolated populations in the Gila River basin.

Gila topminnow populations are primarily replaced by mosquitofish through direct predation on larvae and juveniles and through increased incidence of disease in adult topminnow due to attacks and fin shredding by mosquitofish. The use of mosquitofish in Arizona should be discouraged in most cases and should not be used anywhere there is potential for them to escape into the natural environment and negatively affect our native species.

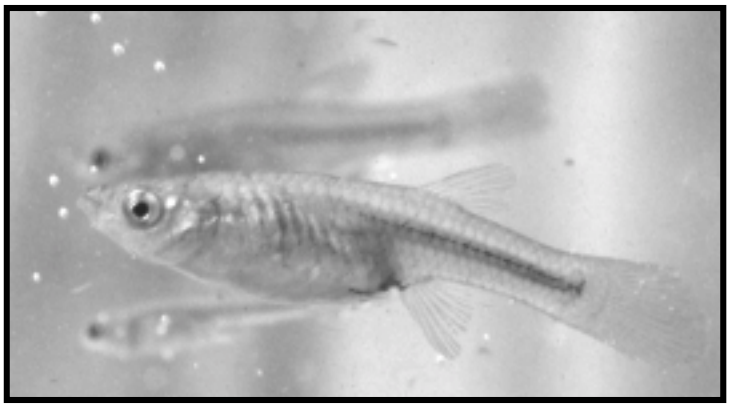
Recent studies have indicated that, "Topminnow appear to be as effective as mosquitofish at mosquito control, under most environmental conditions. Topminnow are desirable for use as a biological control agent in Arizona because they are native to the region and, historically, were widely distributed. In addition, topminnow are listed as endangered, and their use as a biocontrol agent would result in the establishment of more refugia populations, while reducing the need for continued introduction of exotic mosquitofish… so, in the interest of species conservation and recovery, Arizona Game and Fish Department recommends use of (this) species for future mosquito control." (Childs 2001, "*Comparison of Gila Topminnow and Mosquitofish as Biological Control Agents of Mosquitoes"*).

The long-term goal for the recovery of Gila topminnow is to remove it from the endangered species list. The short-term goal is to re-establish sufficient populations making down-listing from endangered to threatened possible. The Arizona Game and Fish Department (AGFD) coordinates an intensive reintroduction and monitoring program to prevent extinction and promote recovery of Gila topminnow. The AGFD Native Fish Program monitors and protects habitats that are occupied by natural and long-lived reestablished populations, establishes refugia populations, and develops partnerships with federal, state, tribal, and private entities. Refugia, or man made habitats, help to preserve unique lineages or species. These populations can be used to restock and/or reintroduce populations into wild sites or provide genetic exchange between refugia populations. Captive populations also serve to increase public awareness and understanding of the status, ecology, and uniqueness of this endangered fish.

We are currently developing a statewide Safe Harbor Agreement (SHA)[a] in coordination with the U.S. Fish and Wildlife Service, which will enable organizations and private landowners to assist in the recovery efforts by harboring refugia populations. The SHA would allow private organizations and individuals the ability to use native listed fishes such as the Gila topminnow on their properties in wetlands and ponds. This would serve two purposes: first to assist in the control of mosquitoes, and second to provide additional populations to aid in topminnow recovery.

Other cooperators in these ongoing activities include the Arizona State Land and State Parks departments, Bureau of Land Management, Forest Service, Fish and Wildlife Service, Bureau of Reclamation, The Nature Conservancy, numerous private landowners, school groups, and municipal water treatment operators.

We have the responsibility to conserve species that have existed for thousands of years before our time. All species, including humans, are interconnected to create healthy ecological communities. An informed and caring public will provide strong support for the conservation of endangered species.



FOOTNOTE:

a. Safe Harbor Agreement--A voluntary agreement under which a landowner agrees to carry out specified conservation measures to benefit a listed species. In return for voluntary conservation efforts and commitments, the agreement will extend assurances (under Federal authority of the Endangered Species Act) to the permittee, allowing future alteration or modification of the enrolled property back to its original baseline conditions.

Mosquito ID Made Simpler

Marc Slaff, Superintendent
Morris County Mosquito Extermination
Commission, Morris Plains, NJ
(Excerpted from Wing Beats, American Mosquito Control Assn—AMCA--Newsletter, Winter 2002)

Sweat dampened my collar and stung my eyes as we stumbled into the woods, through the cat briars and ankle twisting depressions. But heat wasn't the primary cause of my discomfort. I was on my first foray to collect mosquitoes since entering graduate school, having quit a perfectly good teaching job just a month earlier. My guides were my major professor and a seasoned graduate student, and much to my horror and disbelief, they were identifying adult mosquitoes to species as they landed on us. "*Aedes canadensis,*" said the graduate student as one type landed on his arm, "*vexans,*" chimed in the professor as a different beast attacked. Squinting at our tormentors, I was stunned. I remember saying "How on earth can you tell one of these from another—they all look the same to me?" More importantly, I thought that I would never be able to tell one mosquito from another as easily as they could.

Most of my fears were put to rest the following spring when I took a graduate course in Mosquito Biology, but learning to identify mosquitoes was still a slow and painful process. Picking my way through a key that included huge numbers of species took forever one little step at a time. Somewhere along the way, either through a suggestion or the rare personal brainstorm, I came up with a technique to hasten the learning process.

When we see someone we know on the street, there are structural cues we employ to tell who they are. No one obviously, sits with a key of acquaintances to figure out who the person is. Likewise, I figured that by reducing the number of mosquito species you're puzzling over, and concentrating on just a few major characteristics, you could quickly identify the vast majority of them in any samples you take.

In any given area, there are only a few mosquito species that are common or fairly abundant. Sticking with those, a simple table can be developed (with descriptors of mosquito characteristics such as the siphon, pecten, saddle, head setae, antennae, and comb scales) so that even a novice can rapidly determine which of them they have. This can be done for mosquito larvae, and for adults. Naturally larval identification generally requires a dissecting microscope, but adult mosquitoes can often be separated with the naked eye (for those with young, functioning eyes) or with low powered hand lenses.

Remember, you still have to know the structures you're looking at on the mosquito. Almost all keys can show you what the saddle, pecten, upper and lower head setae, scutum, etc., look like. And if you have an unusual or uncommon species, you'll still probably have to suffer through a key the old fashioned way. But using a characteristic table will hasten both the identification and learning process. No one is born knowing how to identify any of these creatures—they simply become familiar to us over time, just like old friends.

Mosquito Connection Submission Guidelines

Your original stories and outside articles are needed to make the *Mosquito Connection* a useful tool for water managers. Submission guidelines are below.

Original articles

In the interest of space, please limit article length to four typed, double-spaced pages, with maximum two photos or graphics. Articles and photos can be e-mailed to the address below. If you mail hard copy photos, please label them with your name and address so they can be returned.

Articles of interest (from journals, etc.)

We also welcome submissions of previously published articles, lists of suggested reading, etc. To the extent possible, we will reproduce these and distribute as newsletter attachments. Of course, entire booklets, or items with multiple color illustrations, cannot be considered.

Submissions are welcome at any time and are held for the next issue.

E-mail articles to: LDSMITH1@MAIL.CI.TUCSON.AZ.US) or send hard copies to the newsletter's return address (ATTN: Linda Smith). For assistance, contact Linda (520-791-5080, Ext. 1465).

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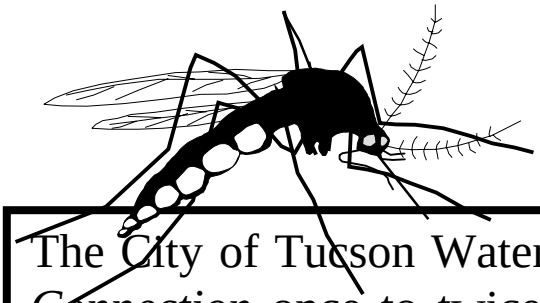

The City of Tucson Water Department produces the *Mosquito Connection* once to twice a year. Its purpose is to provide a forum for sharing information about mosquito control issues at water management projects throughout the state. The content of this publication does not necessarily reflect the views or policies of the City of Tucson Water Department.

Please send your comments to *Mosquito Connection* to the address on the newsletter.